SENN (N.)

With the Compliments of the Author.

A Contribution to a Knowledge of Fracture of the Rim of the Acetabulum, Based on the Reports of Twenty-Seven Cases and Experiments on the Cadaver.

BY

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A Contribution to a Knowledge of Fracture of the Rim of the Acetabulum, Based on the Reports of Twenty-Seven Cases and Experiments on the Cadaver.

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Proposition First.—Fracture of the rim of the acetabulum is an extremely rare accident, being less frequent than fractures involving the floor of the acetabulum.

Proposition Second.—Fracture of the rim may be the result of direct or indirect violence, the force required being greater than is necessary to fracture the floor of the acetabulum.

Proposition Third.—This injury may be completely repaired, pro vided the dislocation attending it is reduced early, and the head of the femur is retained for a sufficient length of time for bony union to take place.

Proposition Fourth.—Crepitus, easy reduction, and difficult retention are the most constant and reliable diagnostic symptoms.

Proposition Fifth.—The best method of reduction is to relax the untorn portion of the capsular ligament, and, by making extension, draw the head of the femur towards the broken portion of the rim.

Proposition Sixth.—The best method to prevent reluxation is to make the unbroken portion of the rim a support for the head of the femur, and to secure immobility to the hip joint, by applying a permanent dressing, including the pelvis and both lower extremities.

Proposition Seventh.—When not a sufficient depth of the rim is left to prevent reluxation by muscular contraction, permanent extension and fixation are necessary for the maintenance of retention.

Anatomy of the Acetabulum.

The acetabulum is so called from its resemblance to an ancient vinegar cup. Primarily, three bones enter into its formation, of which the ilium occupies a little more than two-fifths, the ischium a little less than two-fifths, and the pubis the remaining fifth. It is a deep, hemispherical depression on the outer surface of the os innominatum, where the primary segments of that bone unite. In the erect position, its direction is downwards, outwards, and slightly forwards, so as to receive the head of the femur obliquely. In the dry bone, it forms between 175 and 180 degrees of a circle, but in the recent state it is deepened and con-

stricted by a ring of fibro-cartilage, called the limbus cartilagineus acetabuli, which is firmly attached to the bony margins of the cavity.

The rim of the acetabulum, for convenience sake, may be divided into three divisions, corresponding to its original component parts. The upper, or iliac portion, has to support the whole weight of the body when in the erect position, and constitutes the strongest portion of the rim. Its line of juncture with the pubic portion in front is marked by a shallow indentation, over which passses the ileo-psoas muscle. Its posterior limitation and union with the ischiatic portion, is indicated by a ridge, which extends from the middle of the great sciatic notch to the edge of the rim, where it terminates in a slight elevation. Its anterior third is strengthened by a broad, rough ridge, which blends it with the anterior inferior spinous process, and gives attachment to a part of the capsular ligament, and one point of origin for the rectus femoris muscle.

The ischiatic portion extends from its point of junction with the preceding portion to the cotyloid notch, where it terminates in a sharp projection which partly overlaps this depression, and then turns towards the interior of the joint, and marks the boundary between the articular and non-articular portion of the joint.

The pubic portion commences near the middle of the cotyloid notch, at a point corresponding to the junction of the middle with the upper third of the external margin of the obturator foramen. It gradually ascends until it reaches its greatest height opposite the center of the horizontal portion of the pubis, where it gradually slopes backwards until it terminates at the upper depression in the rim, where it joins with the iliac portion.

We have, then, two depressions in the rim, the upper and lower. The former, marking the junction of the pubic with the iliac portion, permits more complete flexion; the latter is located at the most dependent portion of the joint, and is formed at the expense of the lower portion of the ischiatic and pubic rim.

The cotyloid notch is converted into a foramen, transmitting the vessels and nerves to the interior of the joint, by the transverse ligament which connects the ischiatic and pubic portions, and thus completes the defect in the bony part of the rim.

The interior of the cavity may be divided into articular and non-articular. The articular portion is lined with cartilage, and corresponds to the inner surface of the rim, and the adjoining part of the floor of the joint. It presents the shape of a horse shoe, with the open extremity directed downwards towards the cotyloid notch. This surface is in immediate contact with the head of the femur. The non-articular surface covers about one-third of the interior of the joint. It corresponds to the

area enclosed by the horse shoe, and extends from above the center of the joint to the margin of the obturator foramen; it is devoid of cartilage, and is separated from the head of the femur by the transverse and round ligaments and a quantity of adipose tissue.

The deepest part of the acetabulum is near the center, where the angles of the original bones meet; here the bony wall is sufficiently thin to be translucent if held towards the light.

In most specimens the thinnest part is a little below the center, at the junction of the ischiatic with the pubic portion. It is here where perforation occasionally takes place in disease of the hip joint; it is also here where one line of fracture is usually found in stellate fractures of this bone. The absence of or imperfections in the rim determine the weakest points in the acetabulum.

Anatomy and experience teach that these points exist at the upper and lower depressions, or at the junction of the pubis with the ilium and ischium. The strongest part of the rim and cavity is the iliac, and, therefore, the least likely to become the seat of fracture.

The margin of the acetabulum is composed of cancellated tissue, covered on the inner side by cartilage, and on the outer by a very thin layer of compact tissue. At the margin the cavity is nearly circular, the diameter being the same in every direction. The measurements of 12 acetabula of adults yielded an average of $2\frac{1}{8}$ inches.

The cavity is deeper in males than in females, and in adults than in children and the aged. In children the rim is not fully developed, and in old age it atrophies. The same bones gave an average depth of $1\frac{1}{6}$ inches.

The Y shaped cartilage at the bottom of the acetabulum begins to ossify at the period of puberty.

In regard to the ligaments, I will simply say, that there are attached to the margins of the joint, the transverse, capsular, and the ligamentum teres. The transverse ligament, with the circular fibro-cartilage, completes the brim over the cotyloid notch. The capsular ligament is attached to the outer surface of a greater part of the rim, and over a considerable surface of bone at its base, as well as the transverse ligament, and includes the limbus cartilagineus, without being attached to it. Over the anterior aspect of the joint the margin is free, the ligament being attached to the bone around it, while posteriorly it reaches the edge within a few lines. It is important to remember, in this connection, the extensive insertion of this ligament, far beyond the base of the rim, and that the edge of the rim, and the fibro-cartilage have no connection with it; were the ligament inserted only into the edge of the rim, the latter would be frequently chipped off in cases of dislocation of the femur, by traction of the ligament, as often happens in some other joints.

The ligamentum teres takes its origin from the margin of the cotyloid notch and the transverse ligament, ascends to near the middle of the joint, and is inserted into the dimple on the articular surface of the femur. This ligament takes no part in retaining the head of the femur in the joint, but, according to the experiments of Mr. Morris,* it checks rotation outward during flexion, and adduction during flexion.

EXPERIMENTS ON THE CADAVER.

These experiments were made for the purpose of ascertaining what part of the acetabulum would be most likely to be broken on the application of direct or indirect violence, and to determine the amount of force necessary to fracture its rim. The force was applied by means of a very heavy iron sledge hammer, a three-inch plank being placed over the part to which the blows were directed.

I. Subject, aet. 40, suicide. The body was well developed, the bony structure large. Force was applied to the sole of the foot, with negative result, the pelvis being fixed, and the limb in the extended position. The leg and thigh were then flexed at a right angle, the latter slightly abducted, and the force applied to the knee, the result being an oblique fracture of the femur at the junction of the middle with the lower third. The subject was then placed on the opposite side of the pelvis, and the blows directed against the great trochanter, which caused an oblique fracture of the neck of the femur, extending from within the capsule on the upper border of the neck, downwards and outwards to near the junction of the shaft with the neck; ligamentum teres, and capsular ligament, except at the point of fracture, intact.

II. Subject, aet. 47, died of phthisis. Bones well developed and strong. The body was placed on the back, knee and hip bent at a right angle, thigh slightly abducted, pelvis fixed, and the force applied over the knee. Repeated blows produced a fracture through the lower third, the fracture extending into the knee joint, half way between the condyles. A rent was found in the posterior part of the capsular ligament. The subject was then placed on the opposite side and the force applied directly over the trochanter. On examining the hip joint, the acetabulum was found to be fractured, the line of fracture extending from near the middle of the socket to the upper depression in the rim, and downwards to the cotyloid notch, the detached portion including a little more than the pubic portion of the joint. Ligamentum teres partially ruptured.

III. The subject, same as in No. II, was placed in the knee elbow position, thigh flexed at a right angle and abducted, and the force applied over the posterior aspect of the pelvis, which resulted in a fracture of the

*The Anatomy of the Joints of Man: By Henry Morris, M. A., M. B., London, F. R. C. S., Philadelphia, 1879.

sacro-iliac junction, the fracture being at the expense of the sacrum. Hip joint not injured.

IV. Subject, aet. 35, died of phthisis. Bones large and strong. Body placed on the back, pelvis fixed, and the force applied to the sole of the foot, while the limb was slightly raised. The first blow caused a comminuted fracture of the os calcis and malleolus externus, and by subsequent blows, the tibia sustained a fracture about four inches below the knee joint. The leg and thigh were then flexed at a right angle, and the force applied to the knee, the thigh being slightly *adducted*. After many hard blows, something was felt to give way, and, on making an incision down to the hip joint, the head of the femur was found to be in the ischiatic notch, the neck being embraced by the rent in the posterior portion of the capsular ligament. Rim of the acetabulum intact. Ligamentum teres ruptured completely.

V. Same subject as in No. IV. Force applied to knee-joint, the limb being in the same position, except that the thigh was slightly *abducted*. The fracture thus produced was compound, and affected the femur at the junction of the middle with the lower third. No lesions of the acetabulum or capsular ligament.

VI. Subject, aet. 17, died of renal disease. Body was placed on the back, knee flexed at a right angle, thigh semiflexed and abducted, and pelvis fixed. A blow over the knee joint fractured the femur at the junction of the upper with the middle third, the line of fracture being nearly transverse. The body was then placed upon the abdomen and face, and while the pelvis was firmly fixed, the blows of the hammer were directed towards the posterior margin of the trochanter on the same side. On examination of the hip joint, a portion of the ischiatic rim, adjacent to the cotyloid notch, was found detached and adherent to the capsular ligament. Ligamentum teres intact.

VII. Subject same as in No. VI. The last experiment was repeated and produced the same lesions, with the exception that the fracture in the acetabulum involved its floor, the line of fracture extending from the depression in the upper part of the rim, vertically downward, to the cotyloid notch, separating the pubic portion of the acetabulum without, however, following the line of the Y cartilage. A fracture also took place through the body of the pubis, and through the ascending ramus of the ischium.

REMARKS.

These experiments demonstrate how difficult it is to fracture the rim of the acetabulum, and they tend to corroborate the views of the majority of surgeons, who consider this injury one of the rarest accidents in surgery. They are also instructive in showing where bones are most

likely to break, when a sufficient amount of violence is brought to bear upon certain parts of the skeleton. Thus, although in every experiment the limb was placed in the most favorable position, and the force applied in such a manner as to expend itself on the inner surface of the acetabulum, fracture of the rim was produced only once, and then by forcibly rotating the femur inwards, and by applying the force to the posterior margin of the trochanter.

The rest of the fractures were distributed among different bones, as follows: Shaft of femur, 5; neck of femur, 1; malleolus externus, 1; os calcis, 1; ascending ramus of ischium, 1; body of pubis, 1; acetabulum, 2; sacro-iliac synchondrosis, 1. The head of the femur was dislocated into the great sciatic notch by flexing and adducting the thigh and applying the force to the knee, the pelvis being fixed. It is a noteworthy fact that when the femur in adults was broken, this fracture was very oblique and below the middle of the bone, while in the subject aged 17 years, the fracture was in both instances above the middle, and nearly transverse.

This limited number of experiments would lead me to the conclusion that fractures through the floor of the acetabulum are of more frequent occurrence than simple fractures of the rim, and are the result of a less degree of violence, and that the greater mortality attending them is due to the presence of visceral lesions, rather than the greater extent of injury to the bone.

REPORTS OF CASES.

CASE I. Reporter, Astley Cooper.*—A man was run over by a heavily loaded wagon. On examination it was found that he had suffered a fracture of the right femur above its middle third; the left foot was dislocated outwards, and fibula fractured two inches above the ankle joint; the left thigh was rotated inwards; on making extension and rotating it outwards, a sensation was imparted to the hands, of the head of the femur gliding into the acetabulum, but as soon as the extension was discontinued, the limb assumed its former abnormal position. The patient died on the third day. At the post mortem examination, the posterior portion of the rim of the acetabulum was found detached, and another line of fracture extending into the innominate bone. The ligamentum teres was not ruptured. The head of the femur was slightly dislocated backwards, resting upon the broken edge of the acetabulum.

CASE II. Reporter, Bardinet.†—A young man was thrown violently upon the ground by the upsetting of a wagon. He suffered great pain in the left hip, and could not lie on the affected side. By measurement the limb was found to be two inches shortened, foot and knee inverted,

* Emmert, Lehrbuch der Speciellen Chirurgie, Stuttgart, 1862, Band iii, s. 750.
† Locus Cit., s. 750.

gluteal fold higher, and nates flattened; trochanter displaced backwards and upwards. Rotation was impossible, but adduction could be made without resistance. No crepitation could be felt. The head of the femur was distinctly felt under the gluteal muscles, and was affected by all movements of the thigh. The case was diagnosed as a dislocation of the femur upwards and backwards. The reduction was easily accomplished, and was attended by distinct crepitation. Re-dislocation took place three times, and the reduction was always accompanied by crepitation. It now became evident that the dislocation was complicated by a fracture of the rim of the acetabulum, consequently a permanent dressing was applied, after the fourth reduction, and retained for four weeks, when the patient was discharged, having good use of the limb.

CASE III. Reporter, Maisonneuve.*—This case demonstrates beyond all doubt the existence of this rare injury of the acetabulum, and illustrates the process of repair.

A laborer was severely injured by the caving in of the wall of a stone-quarry. A fracture of the arm was detected; the left hip joint was very tender and painful; shortening of limb three centimetres; knee flexed and foot turned inwards; great trochanter displaced backwards, and more prominent. On moving the thigh, crepitation could be distinctly felt; on making extension, the limb could be brought down to its natural length, and when held in this position, rotation, flexion and abduction could be freely made, but as soon as the extending force was removed, and especially if the limb was adducted at the same time, the shortening and deformity reappeared at once. Simultaneous with the slipping of the bone into the socket, a loud crepitation was heard.

The treatment consisted in fixing the limb in a flexed, abducted and inverted position. Twenty days after the injury was received, the patient died of pyæmia. On examining the joint after death, the head of the femur was found in the socket. The posterior and upper rim of the acetabulum had been broken into three fragments, the lowest and largest of which had formed bony union; the two upper were firmly adherent by means of fibrous union. The rupture in the posterior portion of the capsular ligament was indicated by a cicatrix two centimeters in length. The ligamentum teres was not completely ruptured.

CASE IV. Reporter, James Morton.†—The patient was a miner 18 years of age, who was injured, while at work, by a beam striking against his right hip. Three months after the accident chloroform was administered, and, on examination, the head of the femur was found dislocated upwards and backwards; a portion of the rim of the acetabulum could

* Loc. Cit., s. 750; L. Union Med., 1854, 98.

† British Med. Journ., May 27, 1871; Schmidt's Jahrbuecher, Band 152, s. 179.

be felt just above the head of the femur. The dislocation was reduced by manipulation. The patient was discharged after six weeks, with some shortening of the limb.

CASE V. Reporter, T. Holmes.*—"I saw a case once of dorsal dislocation in which all the symptoms were strongly confirmatory of the diagnosis of fracture of the acetabulum. The dislocation was reduced without difficulty, and nothing peculiar was noticed; but, on visiting the patient next day, the surgeon was surprised to find that it had been reproduced. It was again reduced, but the reduction was found to be quite insecure, for it slipped out as easily as it was put in; and now it was thought that crepitus could be detected. The limb was put up as carefully as possible, but I believe some deformity persisted."

CASE VI. Reporter, Frederick S. Eve.†—This and the following case were reported by Dr. Eve, at the meeting of the Royal Medical and Chirurgical Society, held Jan. 13, 1880.

"A middle-aged man threw himself from an upper story window, and, in addition to fatal injuries to the head, sustained a sciatic dislocation of the right femur, which presented the usual appearances. On dissection, the head of the femur was found on a level with the lesser sciatic notch. The tendon of the obturator internus muscle crossed the upper part of the articular surface, binding the head slightly down, and thus occasioning extreme rigidity of the limb. The posterior portion of the rim of the acetabulum was torn up. Only the posterior segment of the capsule was lacerated. Of the muscles, the gemellus inferior alone was torn. After the dissection was completed, the femur was readily reduced through the cotyloid notch."

CASE VII. Reporter, Frederick S. Eve.‡—"A man, aged 55, had his left femur dislocated in the neighborhood of the great sciatic notch, by a fall of earth upon his back while he was stooping at work. The dislocation presented no unusual character. Reduction was effected by traction on the slightly flexed and adducted thigh, the ordinary manipulations having failed. He died from a rupture of the intestine. On dissection the head of the femur was found to have passed through the posterior portion of the capsule, on a level with the great sciatic notch, and apparently above the obturator internus. The posterior portion of the rim of the acetabulum was torn up as in the first case. The pyriformis, gemellus superior and obturator externus muscles were lacerated."

CASE VIII. Reporter, E. Ried.‖—A healthy laborer, aged 40, was injured in a quarry by several large stones falling upon the posterior

* T. Holmes' Surgery, 1876, p. 243.

† British Medical Journal, January 24, 1880.

‡ Loc cit.

‖ Deutsche Zeitschr. fuer Chirurgie, Band XII., Heft 1-2.

aspect of the pelvis, the man being at work in a stooping position. The physician who was called first diagnosed dislocation of the femur, but failed to reduce it. The patient was admitted to the hospital, when the right limb presented the following appearances: It was adducted and flexed, the knee with its inner surface came in contact with the left thigh above the knee; the foot was inverted, the big toe resting on the dorsum of the opposite foot; the hip was swollen, painful and tender. On account of the swelling it was with some difficulty that the trochanter major could be felt a little higher up and farther back than when in its normal position. The head of the femur could not be felt. The shortening of the limb corresponded to the displacement of the trochanter upwards. Flexion could be effected only to a moderate extent; abduction and rotation were impossible. Chloroform was administered and reduction effected by making extension in the direction of the axis of the limb. As the head of the bone descended crepitation was heard distinctly, after which it slipped into its socket, and the limb dropped into its natural position. On flexing and rotating the limb slightly all the symptoms of the previous displacement returned. The limb was again reduced without the least difficulty, and the patient was conveyed to his bed on a stretcher. On making another examination, all the symptoms of dislocation had reappeared. It was now evident that the dislocation was complicated with a fracture of the upper and posterior rim of the acetabulum. The next day chloroform was again administered, and the limb, having been restored to its natural position, was dressed and rendered immovable by means of Hagedorn-Dzondis' apparatus. As another means of retention, a pelvic band was applied with a compress between the great trochanter and the anterior superior spinous process of the ilium. Four weeks subsequently he was allowed to sit up, and in two weeks more he was discharged, being able at the time to walk without difficulty.

CASE IX. Reporter, E. Ried.*—November 24, 1873, a young man was riding down a steep hill on a hand-cart, guiding the vehicle by the handle held between the outspread legs, his back resting against a barrel of beer behind him. While the cart was in rapid motion his right knee struck against the wheel of a heavy wagon standing by the roadside. He immediately experienced a severe pain in the right hip; the thigh was flexed and immovable. His companions attempted to straighten the limb, but were only partially successful. A physician, who was called, found the thigh shortened six centimetres, and slightly rotated inwards; leg and thigh flexed and firmly fixed, as in cases of dislocation. On account of the extensive swelling, the head of the femur could not be

* Loc. cit.

felt. A dislocation of the femur was suspected, and reduction was attempted by making traction in the direction of the axis of the limb. This procedure diminished the amount of shortening and produced a rough crepitation, which led the physician to the belief that he had to deal with an extra capsular fracture of the neck of the femur. He applied a temporary dressing only, and sent the patient to the hospital. On admission he presented the following status: Extravasation of blood in the right knee-joint, excoriation, suggillation over the posterior spinous process of ilium; on the same side trochanter major above Nelaton's line; right leg shortened nearly two inches; femur flexed, adducted, and rotated inwards; toes directed inwards; abduction impossible; rotation, which was limited, caused crepitus; trochanter major moves in the normal circle; pelvis is inclined on the right side, so that when the limb was brought down a large hollow space appeared at the lumbar and upper pelvic region, which disappeared when the thigh was flexed at a right angle; the head of the femur could not be felt on account of the swelling. A dislocation of the femur, with fracture of the posterior rim of the acetabulum, was diagnosed. The diagnosis was based on the symptoms and the manner in which the injury was produced. Chloroform was administered and traction made, the limb being flexed and adducted; the head of the bone was lifted by a towel placed around the upper part of the thigh, and traction made outwards. The bone returned to its normal place, the reduction being attended by distinct crepitation; retention was maintained without difficulty, as the upper portion of the rim remained intact.

The patient was placed in Bonnet's wire breeches. On the 23d of December he made his first attempt at walking, and on the 16th of January he was discharged, having perfect use of the limb.

CASE X. Reporter, Theodore A. McGraw.*—"I have recently had a case of fracture of the rim of the acetabulum, in which the patient recovered completely, and which I will describe in short.

Miss P——, aged 25 years, was riding on a 'buckboard,' sitting upon it with the left side towards the horse. The wagon wheel struck a stump, and she was thrown on the ground in such a way that she rested for a moment upon her knees and face. The hinder wheel struck and passed over her left hip while she was in this position. She lived at Leesville, five miles from this city, and Dr. Jones, of Leesville, was called to attend her. Recognizing the serious nature of the case, he sent for me. We put the patient under an anæsthetic. I found her left thigh dislocated on the dorsum. In that position the whole shape of the head and neck of the femur could be felt with the hand; it seemed normal in every

* Communication from Prof. Theo. A. McGraw, Detroit.

respect, except as regards its abnormal position. The luxation was easily reduced, but its reduction caused audible and distinct crepitus. When reduced, the two extremities measured the same, and the position of the injured limb was perfect. Adduction produced redislocation with loud crepitus; reduction again caused crepitus. Fracture of the femur was excluded by the equal length and proper position of the thigh after reduction, and by the evidently normal shape of the head and neck of the femur, as ascertained before reduction, also by the ease of reduction. The ease of the redislocation on adduction, and the loud, positive and certain crepitus are my proofs of the existence of fracture.

I fastened the patient, as recommended by Bigelow, with the body on one side of the bed, and the injured extremity fastened in the position of abduction to the other side. Recovery was perfect, and in two months she was able to walk as well as ever."

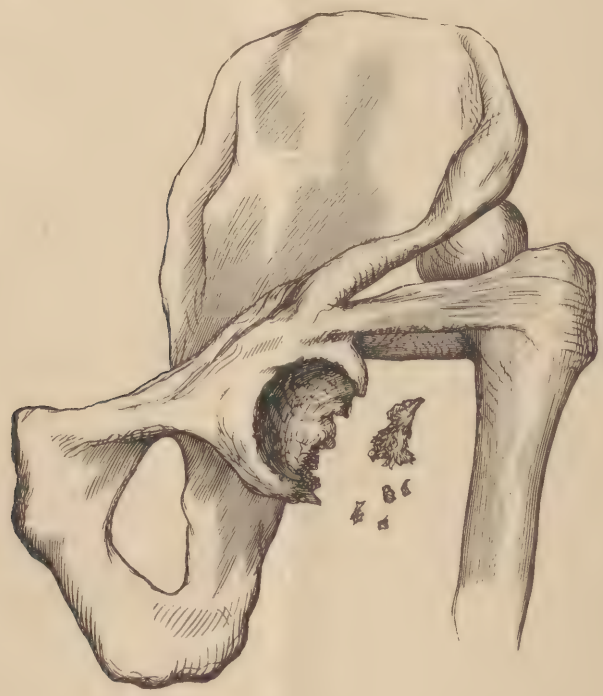
CASE XI. Reporter, H. O. Walker.*—"T. S., aged 78, a street laborer, in attempting to avoid an approaching street car, was knocked down by one of the horses. He fell upon his hands and knees, with his back to the car. In this position the platform of the car struck upon the lower portion of his back, and, as the sequelæ will show, the thigh must have been at right angles with the pelvis, or nearly so, when he received the blow. The injuries received, were a severe scalp wound, a compound comminuted fracture of the forearm, with a number of contusions on different parts of the body. Aside from these there was an injury to the left hip.

He was taken to Harper Hospital and examined by Drs. G. A. Foster and M. K. Ross, who recognized a displacement of the head of the femur upon the dorsum ilii. By manipulation, they detected a distinct crepitus, but were unable to determine positively the exact nature of the fracture. Reduction was easily accomplished. The accident occurred at 4 P. M., and the patient died early next morning, evidently as the result of shock, due to the combination of injuries received. At the inquest the coroner directed me to make a post mortem examination, and I will here only make mention of that part pertaining to the injury at the hip joint. Inspection revealed the head of the femur still in position, but, on slight manipulation of the leg by flexing, and abducting the thigh, the head of the femur readily slipped out of place, accompanied by a marked and distinct crepitus. Further, there was inversion of the foot, marked adduction and flexion of the thigh, with the head of the bone distinctly felt high up on the dorsum ilii, and shortening about three inches. After several attempts it was found that reduction could best be effected by

* Fracture of the Posterior Lip of the Left Acetabulum, with Specimen. By H. O. Walker, M. D., Lecturer on Anatomy and Genito-Urinary Diseases in Detroit Med. College. "Detroit Lancet," July, 1879.

flexing, extending, adducting, and straightening the thigh. On exposing the femur and contiguous parts, it was observed that the head of the bone had been forced upwards between the wings of the ileo-femoral ligament, extending nearly up to the brim of the pelvis, midway between the anterior and posterior superior spinous processes.

The ligamentum teres, and the greater part of the posterior half of the capsular ligament, was torn away, leaving a part of the anterior portion, together with the ileo-femoral or Y ligament. The muscles of the lower gluteal region at the femoral attachment were more or less ruptured. The fracture of the rim of the acetabulum can be better appreciated by the specimen which I removed, and herewith present for your inspection.



DR. WALKER'S CASE OF FRACTURE OF RIM OF ACETABULUM.

The fragments which you see, were all detached and picked out from the cavity that had been made by the head of the femur. You will notice

that the greater part of the posterior lip of the acetabulum is torn away, making an opening through which the head of the bone could readily escape, leaving a little less than a third of the depth of the cotyloid cavity intact, as a support to the head of the bone posteriorly."

CASE XII. Reporter, J. H. Beech.*—"On July 1, 1872, Mr. S. J. B——, a young farmer of fine proportions, sound constitution, and of good habits, aged 21 years, was upon the top of a large load of hay, driving into his barn, when he was caught by the frame-work over the door, and rolled into an irregular heap, from which his associates and himself found it impossible for them to straighten him. He stated that after he discovered that the load was too high for the doorway, and that his horses were under too strong headway to be stopped in time to save him, he endeavored to straighten himself as flat as possible upon his back, but that his 'left knee was caught,' with the result as above stated, and that he felt a crushing, as if he was being torn in pieces. It was probably less than an hour before I was at his side, and found all the evidences required for a diagnosis of dislocation of the left 'caput femoris,' upon the dorsum ilii. * * * * * *

Attempts to rotate the limb outwards caused great pain. No crepitus could be felt. Placing the patient upon a hard, level bed, and inducing anæsthesia by chloroform, we proceeded to flex the knee, carrying it at the same time across the right limb and keeping the heel well everted; when the knee was opposite the right hip, a little pressure toward the body was begun, and continued with slightly stronger eversion of the heel, until the knee was brought closely over and nearly past the umbilicus, when the forcible eversion of the heel was discontinued, the knee carried outward to a line with the left axilla, at which time a sensation as of gentle sliding of the caput femoris was felt, and the foot was immediately brought down to the side of its fellow, with the leg, knee and thigh in its proper relation to those parts of the limb. There was no doubt in my mind that I had reduced an outward and backward dislocation of the left caput femoris, by what is called Dr. Reed's method, although there had been no audible snap, nor sudden motion, as I had felt in former cases. We now bound the patient's knees and legs together by a wide, strong towel, reaching from above the patella to the malleoli. Anodynes were ordered to be given if he suffered much pain, or if the supine position became irksome for endurance. On the following day my surprise was great to find the injured limb one and one-half inches shorter than its fellow, and slight but not fixed eversion of the toes, all other positions being as we left them. The patient had not complained

* Toledo Medical and Surgical Journal, April, 1877.

of much pain, and had not been known to move the hips or lower limbs, nor had he been aware of the shortening.

Recalling to mind the quiet manner in which the final moves in my efforts at reduction had been effected on the previous day, I suspected fracture of the acetabulum, and, upon mature reflection, could but negative any other supposition of error. Seating myself at the foot of the bed, in good position for protracted traction, I seized the heel and instep and commenced gentle extension, charging the patient to avoid muscular resistence, and found him a model of courage, resignation, and confidence. After a moment of involuntary contraction, against which I did not apply additional force, I could feel a yielding to my effort, and in less than ten minutes the normal length of the limb was restored. The patient stated that 'the stretching made it more comfortable.' Transferring my grip to other hands, I carefully examined the cresta ilii, and found them relatively correct.

Having informed my patient and his attendant friends of what seemed to be the new revelation, we proceeded to the *experimentum crucis*, to wit: Having the extension gradually relaxed, watched, with my hands pressed over the trochanter major of either side, for tactile sensations, I believed, but was not sure, that I felt crepitus. The retraction was extremely slow, and it was about twenty minutes before the patella appeared, an inch above its fellow. Again traction was made by an assistant, and I felt the same individual crepitus, or, more properly, friction, in its progress. The patient said that "it hurt a little, in one spot." We now attached a weight of five pounds by a cord running over the roll at the foot of the bedstead, which we caused to be elevated two bricks' thickness, and kept the patient *secundum artem*, for six weeks, with the usual minor details and modifications. After this period, he was careful in resuming the erect position, bearing no weight upon the foot for about one month longer, and finally resuming the use of the limb as far as practicable, which is to-day far from perfect."

Dr. Beech examined the patient four years after the injury, and found that he had to wear about one inch additional thickness under the heel of the injured limb, and that, even with this contrivance, he walked with a decided halt. The foot could be inverted or everted, but when the whole weight of the body rested upon it, it was slightly everted. Immediately above the acetabulum a hard substance could be found, which was supposed to be provisional callus.

CASE XIII. Reporter, Julius F. Miner.*—This, in every respect a remarkable case, is the only one I have been able to find where the rim

* Buffalo Medical and Surgical Journal, Vol. V., p. 383.

of the acetabulum was fractured by a gun-shot wound without producing a more extensive fracture of the joint. Prof. Miner very kindly sent me a photograph of the patient for inspection, which accurately shows the position of the limb after recovery.

"Lieut. Col. James Strong, of the Thirty-Eighth New York Volunteers, now Brigadier General of the Veteran Reserve Corps, was wounded May 5, 1862, at the battle of Williamsburg, Va. The ball entered a little below the anterior superior spinous process of the ilium, and made its exit near the outer margin of the sacrum. The ball passed deeply, and fractured, in its course, the rim of the acetabulum, which was removed, an inch and a half in length, and of a diameter sufficient to show that the whole upper rim had been carried away. This fragment of bone was removed from the wound at the dressing made in the hospital, where he was carried after having lain on the field for some hours. Surgeon N. J. Berry first dressed the wound and removed fragments of bone and portions of pants and drawers. The wound was very large, and a thorough examination could be made by the easy passage of the finger."

For the purpose of giving the patient the best possible chance to recover, he was removed to his home in Buffalo, where he was placed under the care of Prof. Miner. * * * * * "The leg was partly flexed upon the thigh, and the thigh upon the body, the whole drawn internally to a considerable extent. In this position it was fixed; it could not be moved in the slightest degree without producing pain, which was absolutely unendurable."

"The constitutional disturbance at length became very great, and the question of life, rather than the position of the leg, engrossed all attention. Fragments of clothing and spiculæ of bone were at various times extracted or washed from the wound, while great quantities of pus constantly issued. * * * * * In this condition of extreme distress and uncertainty of life, he continued without great change for eight or ten weeks, when he gradually and very slowly commenced to improve, both in his general condition and in the appearance of the wound, until, after a few weeks more, he could be moved from one side of the bed to the other, and his comfort promoted by change of position. When at length it became evident that his recovery was probable, the question of the condition of the leg was again agitated, and efforts were early made to extend it and obtain motion in the knee joint. Extension and counter extension under the influence of chloroform was adopted, and persevering efforts made to obtain as favorable results as possible. Nothing, however, can be said to have obtained greater motion in the knee joint, the hip being made neither better nor worse. Abcesses occasionally formed in the site of the old wound, and continued to

do so for eighteen months or two years, each time indicating great constitutional disturbance, sometimes so great as to excite fears of his life."

When recovery finally took place, the following was his condition: "The thigh is shortened nearly five inches, the head of the femur rests upon the ilium above the acetabulum, and a complete and bony anchylosis exists; the knee is drawn inwards, and has good motion. The weight of the body can be borne upon the leg with comfort, and the twisting of the pelvis and the extension of the toes compensates for the shortening and stiffening, in a wonderful degree, so that he walks with or without a cane, with but slight disability, considering the severity of the injury and the unnatural condition of the articulation." * * *

"A gun-shot wound, such as related, carrying away the rim of the acetabulum and allowing the muscular contraction to dislocate the femur, drawing the head upwards and backwards, must be a very severe and dangerous injury. If such cases have occurred, they have more generally died from either shock, hemorrhage, or inflammatory action and traumatic fever, within a few days—have rarely continued under observation long enough to accurately determine their nature, or the results of imperfect recovery."

CASE XIV. Reporter, J. H. Pooley.*—This case is reported by Prof. Pooley, more for the purpose of showing the utility of the fulcrum in reduction of dislocation of the hip, as advised by Dr. Sutton, than with any special reference to the fracture under consideration, but as both Dr. Dunlap and the reporter considered the existence of the fracture an *obstacle* to the reduction, I will report it in this connection.

"October 19, 1876, I was requested by Dr. Dunlap, of Springfield, Ohio, to see, in consultation with him, a case of dislocation of the hip, in which he had failed to effect reduction after a fair and repeated trial of the ordinary method of manipulation.

"The patient, the wife of a farmer residing near Catawba, Clark County, Ohio, about fifteen miles from Springfield, had been thrown from a wagon the day before, about four o'clock in the afternoon, and had sustained a dislocation of the hip. She had been first seen by Dr. John Clark, of Mechanicsburg, who had been unsuccessful in his attempt at reduction.

"Dr. Dunlap had then been sent for, and had made repeated attempts to reduce the hip, but also without success. All the attempts had been manipulation. Pulleys had not been used. I arrived at the house on the next day, early in the morning. I found the patient, a spare, nervous

* American Practitioner, December, 1876.

woman of thirty-three, in bed, suffering considerably from pain, and severely from nausea, the result of chloroform which had been administered on several occasions.

"The left limb was an inch and a half shorter than its fellow, the foot very slightly everted, and the head of the bone could be plainly felt in front of the ilium, just above the acetabulum. Dr. Dunlap informed me that the dislocation had been primarily on the dorsum ilii, and the present position of the head of the femur was the result of the last manipulation. It had been found, on manipulating it, to be extraordinarily movable, and had been carried once or twice into the thyroid foramen, and also up on the ilium just above the acetabulum, in which situation I found it. In fact it would go almost anywhere, except into the right place. Dr. Dunlap said that he had carried it right across the acetabulum on two occasions, and, as he did so, he felt a distinct crushing crepitus, but it went over and not in. His belief, which I presume was correct, was that a portion of the lip of the acetabulum was broken off, and, as the head of the thigh bone was brought up against this broken portion, it was forced before it, and, partially filling up the acetabulum, prevented it from going in, and guided it over to the other side instead. I directed, according to Dr. Sutton's plan, a firm cylinder to be made, by tightly and evenly rolling two sheets, which was three inches in diameter and about two feet in length; it was firmly tied round with narrow strips of bandage to prevent its unrolling. The patient was now anæsthetized and laid upon the floor; the cylinder was now placed across the upper part of the thigh in the groin, and firmly held at each end by an assistant; over this, as a fulcrum, Dr. Dunlap made the manipulation, while I attempted to follow the excursion of the bone with my fingers. The two first attempts failed, as I very plainly saw, from not fully carrying out the principle involved in the use of the fulcrum; that is, by abducting the knee before complete flexion of the thigh over the cylinder had been accomplished. The first time the head of the femur lodged in the thyroid foramen, the second time at the top of the ilium, where it was when we began; it had skipped round the base of the acetabulum without rising to its level, much less going into it. The third trial, in which the principle of the fulcrum was deliberately and thoroughly carried out, was perfectly and speedily successful. The thigh was slowly and fully flexed on to the abdomen over the fulcrum, the head of the bone was lifted up to a level with the acetabulum, and when the knee was abducted, and the motion of bringing the thigh down barely commenced, it slipped in with a distinct snap; the limb was found to be restored in length and position and the dislocation was reduced. A broad, firm, pelvic bandage was applied, and the patient returned to bed.

"This may almost be looked upon as a test case for the new method. Ordinary manipulation had been tried by skillful hands, in which it had never before failed; and I think that there can be but little doubt that Dr. Dunlap's explanation of his failure was the correct one. What was wanted there was some means by which the head of the femur could be carried up to a level with the top of the acetabulum, and thus prevented from pushing the broken acetabular rim before it. This was found in Dr. Sutton's method; the obstacle was overcome and the reduction accomplished."

CASE XV. Reporter, Frank H. Hamilton.*—"February 3, 1847, a strong German laborer was crushed under a mass of iron weighing several tons. Drs. Sprague and Loomis, of Buffalo, were called, and found the left thigh dislocated upwards and backwards, and, by the aid of six men, they succeeded in reducing it, the reduction being attended, as the gentlemen have informed me, with a slight sensation of crepitus. The legs were then laid beside each other, and the knees tied together, the patient lying on his back, and now the two limbs appeared to be of the same length. On the second and third days the injured limb was examined by the same gentlemen, and there was no displacement; on the fourth day I was invited to meet these gentlemen, the patient having had muscular spasms during the previous night, and the thigh being reluxated. I found the limb shortened one inch and a half, adducted, and the toes turned in. We immediately applied the pulleys, and soon drew the trochanter down to a point apparently opposite the acetabulum, and a careful measurement showed that the two limbs were of the same length. The pulleys being removed, the leg did not draw up again nor did the foot turn in, yet we had felt no sensation to indicate that the bone had slipped into its socket, nor had we felt crepitus. The legs and thighs were now laid over a double inclined plane and well secured. He remained in this condition for three days more, during which time Dr. Sprague saw him each day and found nothing disarranged. On the night of the seventh day the spasms returned, and in the morning the thigh was displaced. The next day we again applied the pulleys, but soon found that the bone would not remain in place one minute after the pulleys were removed. At this time, while moderate extension was being made at the foot, by rotating the foot inwards, we could distinctly feel a slight crepitus. A straight splint was applied and as much extension made as he could conveniently bear, and in this condition the limb was kept several weeks. Seven years after I found the thigh still displaced upon the dorsum ilii; he limped badly, but he could walk fast and perform as much labor as before the accident."

* A Practical Treatise on Fractures and Dislocations. By Frank H. Hamilton, A. M., M. D., L L. D. Philadelphia, 1871.

CASE XVI. Reporter, Mr. Keate.*—This case is interesting from the fact that the lower portion of the rim was fractured and the femur dislocated downwards. The head of the femur could be felt lying against the tuber ischii, and a distinct grating of the broken off cartilaginous rim could be felt. The posterior and upper part of the rim being complete, there was no trouble in keeping the bone in its position after reduction had been accomplished.

CASE XVII. Reporter, Dr. McTyer.†—A man, aged 27 years, was injured by a number of bricks falling upon his back, his right knee being placed on the bank of a trench. His right leg was found shortened about an inch and a half, flexed, and the foot a little everted. Motion of the limb was not much impaired, but was attended by great pain and crepitus. On making extension the limb was easily brought to the same length with the other, but it became shortened again immediately when the extension was discontinued; the symptoms resembling fracture of the neck of the femur.

The usual treatment for such cases was pursued. Subsequently the toes became slightly turned in, but this circumstance was not regarded as sufficient evidence to justify a change in the diagnosis. In a few days the patient died from his injuries. On dissection, about one inch and a half of the upper and posterior portion of the rim was found completely detached and held in place by a portion of the capsular ligament; the bottom of the acetabulum was also fractured. The head of the bone could be easily dislocated upon the dorsum ilii, the fragment of the acetabular margin being moved aside and swinging upon its fibrous attachment as upon a hinge, but resuming its place again perfectly when the head of the femur was restored to the socket. The femur was not broken.

CASE XVIII. Reporter, Dr. McTyer.‡—"In this case the limb was found shortened, the knee slightly bent and turned a little forwards and inwards, and the toes pointing to the tarsus of the other foot. It was thought to be a fracture also of the neck of the femur, but the autopsy disclosed only a fracture of the upper margin of the rim of the acetabulum."

CASE XIX. Reporter, Dr. McTyer.‖—In this case, seen only after death, the limb was not shortened much, but the toes were stretched downwards, and turned slightly inwards. It was supposed at first to be simple dislocation, but on dissection, the posterior and inferior margin of

* Ibid., and American Journal of Med. Sciences. Vol. XVI., p. 225.
† Ibid., and Glasgow Medical Journal, February, 1830.
‡ Ibid.
‖ Ibid.

the acetabulum was found to be broken, and displaced towards the coccyx, while the head of the femur rested upon the pyriformis muscle, over the ischiatic notch.

CASE XX. Reporter, Dr. McTyer.*—This case came under observation in the dissection room. A fragment of the superior and posterior margin of the acetabulum had been broken off, and had reunited, slightly displaced.

CASE XXI. Reporter, W. L. Faxon.†—Mrs. Faxon, aged thirty-five, wife of the reporter, was thrown from a buggy while driving, Oct. 1st, 1877. When taken up, there were symptoms of dislocation or fracture of the right femur. Examination proved the existence of a fracture of the lip of the right acetabulum, and dislocation of the head of the femur upwards and backwards, with about four (4) inches shortening. The fracture was so near the floor of the acetabulum that there was no sensation of the head of the femur being lifted in its passage over the broken edge of the socket. Drs. John H. Gilbert, of Quincy, and Samuel Cabot, of Boston, assisted the husband of the patient, and confirmed the diagnosis. Desault's splint was applied, but the patient's condition—she being five months pregnant, and suffering from constant vomiting from the time she was injured—necessitated its removal. Her husband then constructed a bed, of which a lengthy description is given, the most important features, however, being the use of sand-bags for the purpose of keeping the limb quiet and making gentle extension and counter-extension. The pain and vomiting ceased after this dressing was applied. On January 4, 1878, she was delivered of a healthy child. One year from the time of injury, she was able to walk, and the prospects were favorable towards a complete recovery.

CASE XXII. Reported by John Eric Erichsen.‡—This case came under Mr. Erichsen's observation at the University College Hospital. The patient was a strong, muscular man, about 30 years of age. It is not stated how the injury was produced. The limb was shortened, inverted and the head of the femur could be felt in the sciatic notch. Reduction was easily effected by extension, and was attended with distinct crepitus, but as soon as extension was discontinued, the head of the bone slipped back to its former locality.

CASE XXIII. Reporter, D. Hayes Agnew.‖—"In a case of this injury recently under my care, in a very prominent citizen of Philadelphia,

* Ibid.

† The Boston Medical and Surgical Journal, Feb. 20, 1879.

‡ The Science and Art of Surgery, by John Eric Erichsen, Philadelphia, 1873. Vol. I, page 364.

‖ The Principles and Practice of Surgery, by D. Hayes Agnew, M. D., LL.D., Philadelphia, 1878, Vol. I, page 929, and communication from the author.

there was no shortening of the limb, although the most careful measurements were made. Pressure over the body of the pubis caused no pain, and the patient was able to sit up and ride a distance of nearly two miles to his home after the accident. He was able to raise the limb, and to flex the leg upon the thigh, and the thigh upon the abdomen; he could invert and evert the toes; there was no crepitus like that of fracture, and he had entire command over the bladder. The only movement that caused him pain was the attempt to turn upon the side, and this occasioned violent muscular spasms. When the thigh was flexed upon the pelvis, and then rotated, the arc of the circle described was uniform up to a certain point, but beyond that, the head of the bone appeared to slip. On the strength of this peculiar symptom, a fracture of the lip of the cotyloid cavity was suspected, and the treatment adopted accordingly. A subsequent autopsy not only proved that this was the case, but also revealed a fracture of the floor of the acetabulum, through which the finger could be thrust from the pelvic side."

CASE XXIV. Reporter, James Dorland.*—Dr. Dorland informs me that while on a visit to his former home in Canada, he was called to see Mrs. J——, aged 25 years, who had suffered an injury of the left hip joint three years before. At that time she was three months pregnant, and, while walking on the wet floor, slipped and fell heavily on the left side. In the evening a physician was called, who diagnosed a dislocation of the femur upwards and backwards, and proceeded to reduce it. This was done without any difficulty, but the bone would not remain in place. The reduction was attended with crepitus, and the head of the femur could be distinctly felt when out of place. The bone was reduced on four different occasions, but relaxation followed every time, in spite of all measures employed to keep it in place. She was kept in bed for four weeks, and for five months subsequently she managed to move from one place to another by means of a chair. The delivery took place at full time, and was not attended by any special difficulties. When Dr. Dorland examined her, the limb was shortened two inches, and the toes turned inwards. She walked quite lame, but without the aid of either cane or crutches.

CASE XXV. Reporter, N. Senn.†—J. D——, aet. 22, a strong, muscular man, was injured May 1, 1872, while pushing a hand car before him; another car, coming from behind with greater speed, knocked him down. He first fell on his knee, and then received the principal blow upon the posterior and left aspect of the pelvis, just above the great trochanter.

*Personal Communication by Dr. James Dorland, Milwaukee, Wis.

†Three Cases of Rare Dislocation, by N. Senn, M. D., Milwaukee, Wis. The Medical Examiner, Jan., 1873.

The patient immediately experienced great pain in the left hip, and was unable to walk. The physician who was called diagnosed a dorsal dislocation of the femur, which he reduced very easily by slight manipulation. He saw the patient several times afterwards, and expressed himself as satisfied with the progress of the case.

For a number of days the pain continued to be severe, but gradually subsided. In a few weeks he attempted to walk, but found it impossible to rest the weight of the body on the afflicted limb. Two months after the accident he applied to me for treatment. I found the thigh flexed upon the pelvis, the knee and foot turned inwards, and the limb shortened two inches; the head of the femur could be distinctly felt upon the dorsum ilii, and responded to all movements of the thigh. Mobility very slight. The patient being desirous that at least a faithful attempt should be made to reduce the dislocation, I called Drs. Löhr and Lueck to render assistance. The patient was placed profoundly under the influence of ether. The adhesions were ruptured, and Reed's manipulation repeated several times without accomplishing the desired object. Extension and counter-extension were now made by a number of assistants, with the result of lengthening the limb nearly, but not quite, to its normal length. The patient was then placed in bed, and permanent extension applied by means of a weight and pulley. One week subsequently we again placed the patient under the influence of ether, and made extension with the pulley, the thigh being adducted and rotated inwards, proper counter-extension being made at the same time. After using considerable force, the head of the femur advanced with an ill-defined sensation of crepitation, to a point opposite the acetabulum. While an assistant continued the extension, the limb was brought down to its natural position, and, on accurate measurement, was found to be of normal length.

The upper margin of the great trochanter was found to correspond to Nelaton's line. While held in this position, rotation, abduction, adduction and flexion could be made with ease, but as soon as traction was suspended, and especially if the thigh was adducted at the same time, the head of the femur slipped back upon the dorsum ilii, accompanied by the same rough, grating sound as it left the socket, as was heard and felt during reduction. I could distinctly feel the head of the femur glide over the smooth surface of the acetabulum, and, as traction ceased, it appeared to rise a little and pass over a rough edge, and then, without any further obstacle, it receded to its former abnormal position. We repeated this experiment several times with the same result. We were now satisfied that there existed with the dislocation, a fracture of the upper and posterior portion of the rim of the acetabulum. After bring-

ing the limb into its natural position, we applied extension by weight and pulley; at the same time we aimed to press the head of the femur against the floor of the acetabulum, by applying a broad, pelvic band. It was found impossible to keep the bone in place, and after three weeks' persistent efforts, all further attempts were abandoned, the former deformity having gradually returned.

CASE XXVI. Reporter, H. J. Bigelow.*—This case occurred at the Massachusetts General Hospital, under the care of Dr. Gay.

"The patient, aged 36, a robust and healthy man, fell from the roof of a building, striking upon the right hip. In the recumbent position, the leg was shortened and inverted, the toes crossing the opposite instep. Being etherized, the thigh could be flexed at a right angle with the abdomen, there being crepitus in the region of the neck of the femur. The limb, when drawn down, was still shortened half an inch. The patient having died of other injuries, the autopsy showed the head of the bone partially dislocated backwards and resting upon the posterior fractured edge of the socket, the whole posterior wall of the socket having been broken away in a mass. The detached fragment measured one and a half inches square. The posterior surface of the head of the bone was deeply indented by the fractured edge of the acetabulum, against which it had impinged after displacing the portion broken off. A transverse crack extended through the acetabulum from the upper sciatic notch to the foramen ovale. The position of the limb in this case did not differ from that in the usual partial dislocation behind the tendon, and was determined by the same mechanism."

CASE XXVII. Reporter, M. Richet.†—"The patient, 58 years of age, was caught by a revolving belt The right limb was shortened a quarter of an inch, and so far everted and straight that the internal condyle of the left femur lay in the popliteal space of the injured one; the right groin was filled up; towards its middle, and outside the femoral artery, was a hard, resisting and obscurely spherical tumor, masked by the glands and swollen tissues. Flexion with outward rotation and local downward pressure failed to reduce the luxation; but, on a third trial, flexion and downward pressure during slight abduction, instead of outward rotation, succeeded. Seven months afterwards the death of the patient having occurred from another cause, a post-mortem examination showed a united fracture of the socket, comprising the external and anterior third of the rim with the two anterior spinous processes of the ilium."

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*The Mechanism of Dislocation and Fracture of the Hip, by H. J. Bigelow, M. D., Philadelphia, 1869.

† Ibid., and M. Berand, Bulletin de la Soc. de Chirurg., 1862. Tom. III., p. 185.

CAUSES.

The older works on surgery mention direct and great violence as the only cause of fracture of the acetabulum; indeed, until recently, it has been considered impossible for a fracture of the rim to take place without more extensive injury to the ilium. When the rim is broken by direct application of force, it is usually the result of a severe fall or blow upon the great trochanter or pelvis; or the producing cause may be still more direct, as when a bullet in its course chips away the brim, as was the case in the very interesting and, to my knowledge, unique case reported by Prof. Miner. When the force is applied over the center of the great trochanter, in the direction of the axis of the neck of the femur, the head of the bone is driven directly against the socket, and a stellate or perforating fracture of the acetabulum is the result; but if the force is applied in such a manner that it first rotates the femur outwards or inwards, then one margin of the acetabulum acts as a fulcrum to the neck, and the head is forced against the opposite side, and a linear fracture through the acetabulum (experiment No. VI), or fracture of the rim (experiment No. VII) may take place. In such cases, the traction of the capsular ligament may assist the head of the femur in producing the fracture of the rim, but without additional assistance such traction is not sufficient to produce the injury. When the force is applied to the posterior part of the pelvis, as was done in Cases III, VII, VIII, XI, XVII, and XXII, the pelvis becomes the movable point, and the foot, if the leg is extended, or more frequently the knee, becomes the fixed point and furnishes the necessary amount of resistance.

At the moment the injury is received, it is essential for the thigh to be *abducted*, as adduction would favor a dislocation by the head of the femur gliding over the inclined plane of the internal surface of the acetabulum (Experiment No. IV.) The pelvis may be the fixed point, as in case IX, and the force transmitted through the femur by blows or falls upon the knee. In most of these cases the thigh was more or less flexed at the time of injury, hence, in the majority of cases, the upper and posterior segment of the rim was fractured, and the head of the femur dislocated into the upper sciatic notch, or upon the dorsum ilii.

Of the twenty-seven cases, eighteen were males, four females, and in the remaining five the sex is not stated. The disproportion between the males and females is explained by the fact that the former are more frequently exposed to severe accidents. The same may be said in regard to age. The extremes of the ages were eighteen and seventy-eight years, so that most of these cases occurred during the time of life when most exposed to grave injuries. It is also well to remember that in young individuals, dislocation and diastasis occur in preference to fracture,

while in the aged, the altered position of the neck of the femur as well as the increased fragility of its substance, are potent predisposing causes of fracture of the neck of the femur.

SYMPTOMS.

The symptoms presented by a case of fracture of the rim of the acetabulum are those of dislocation and fracture combined, the symptoms of the former resemble ordinary dislocation, while the latter are directly referable to the broken bone itself. A certain degree of displacement of the head of the femur was present in all cases where a diagnosis was made during life. Benjamin Travers* believed that in some cases of fracture of the rim of the acetabulum, the displacement takes place gradually some time after the injury has been received, but it is more probable that these were cases known and described by Hueter† as inflammatory dilatation of the acetabulum, the interstitial absorption of the margin of the cavity permitting the head of the femur to glide upwards and backwards. In twenty-four cases the direction of the dislocation is mentioned, of which in fifteen the head of the femur was dislocated upwards and backwards, in four into the great sciatic notch, in two directly backwards, in two downwards, and in one case forwards. It will be seen, then, that in a large majority of cases, that portion of the rim is fractured which is in the direction of the usual form of dislocation, so that the same injury which produces a dislocation may also cause a fracture, provided it is sufficient in intensity and the limb *abducted* at the time the injury is sustained.

The amount of shortening corresponds to the distance the head of the femur recedes from the socket. In Agnew's case, no shortening could be detected on careful measurement. In all of the other cases, where mention is made of this symptom, it was present, but varied in degree from one-fourth of an inch to four inches. If the head of the femur has left the socket, the position of the limb is the same as in simple dislocation, the direction being determined by the form of dislocation.

Flexion to a greater or less extent was present in all cases where reference is made to this subject. Inversion of the foot and rotation of of the femur inwards, were present in fourteen cases, while the opposite condition existed in three cases, and in ten cases no mention is made this symptom. When the dislocation was complete, the limb remained immovable in its abnormal position, until reduction was effected. The characteristic symptoms of the injury are those which are referable to the

* Further Observations in Surgery, 1860, p. 27.

† Klinik der Gelenk-krankheiten von C. Hueter, Leipsig, 1876, Zweiter Theil, Seite 316.

fracture itself, and these are crepitus, easy reduction, and difficult retention. Crepitus is always an important symptom in ascertaining the existence of a fracture. If it is distinctly felt, there can be no further doubt that a bone has been broken. The presence of this symptom is of special diagnostic importance, in connection with this subject, as the symptoms of dislocation are usually so prominent as to engage the whole attention of the surgeon. In the cases reported, this symptom is alluded to eighteen times, and in the following terms: distinct, eleven times; faint, once; marked, twice; indistinct, once; slight once, and in two cases it was absent.

Bigelow places great stress on the presence of this symptom in rendering a diagnosis, when he says in his work previously quoted:* "To afford satisfactory evidence, cases of this sort should have been identified by autopsy or at least by crepitus." I believe that the crepitus is not the same as in ordinary fractures, as in these instances it is the result of two rough, bony fragments rubbing against each other, while in these cases it is a roughness we obtain by rubbing an articular surface against a broken surface of bone, hence, not quite as loud and distinct. The detached margin of the acetabulum, unless comminuted, remains attached to the capsular ligament, and is pushed before or aside of the head of the femur at the time dislocation occurs, and is dragged after it when reduction takes place. In most of these cases it is clearly stated that crepitus was felt just before the head of the femur slipped into the socket, or at the moment reluxation took place, and in both instances it must have been produced by the head passing over the rough, broken edge of the acetabulum. In the few cases where crepitus was felt while the femur was in the dislocated position, it must have been the result of the head rubbing against the detached portion of the rim.

The ease by which reduction was effected has attracted the attention of almost every observer. This is due to a more extensive laceration of the capsular ligament than in simple dislocation, and also to the removal of the obstacle offered by the intact margin of the acetabulum. By the fracture of the rim, a more direct and even route has been prepared for the head of the femur to return to its socket.

Reluxation has always constituted the most perplexing feature of these cases. Its occurrence has usually led to a more thorough examination and correct diagnosis. It is well known that in ordinary dislocations of the hip joint, when the bone has been once reduced, it remains in its place regardless of the after treatment, differing greatly in this respect from the same lesion of the shoulder joint, on account of the greater depth of the socket, and the action of more numerous and powerful

* Page 159.

muscles for maintaining retention. Hueter* believed that the cases of habitual dislocation of the hip joint reported by Karpinski† may have been the result of injury to the rim of the acetabulum.

Reluxation takes place from the inability of the defective margin to resist muscular contraction. The difficulty in retaining the bone is increased by the depth of the fracture, and its approach to the junction of the superior and posterior portions of the rim. In this connection it is important to determine what portion of the rim is most frequently the seat of fracture. In twenty of the cases, special mention was made of this fact, as follows: Superior portion of rim, two; superior and posterior, seven; posterior, five; posterior inferior, four; inferior, one; anterior, one. When the inferior or anterior portion of the rim is fractured, there is no tendency to reluxation, provided the limb is kept in the extended position and slightly inverted.

DIAGNOSIS.

A most thorough and critical examination, while the patient is profoundly under the influence of an anæsthetic, is always necessary to establish a positive diagnosis. If spontaneous reluxation does not follow immediately after reduction has been accomplished, and there are sufficient symptoms present to warrant a suspicion of the presence of the injury, it would be advisable to test the functional integrity of the acetabulum by flexion, adduction and rotation of the thigh; if any part of the rim has become defective by fracture, reluxation will be sure to take place. This maneuvre, associated with the presence of crepitus, may be regarded as the crucial test.

The differential diagnosis must consider fractures of the neck of the femur with displacement, and simple dislocation. To distinguish this fracture from fracture of the neck of the femur, it is necessary to compare their most prominent symptoms:

FRACTURE OF THE RIM OF THE ACETABULUM.	FRACTURE OF THE NECK OF THE FEMUR WITHOUT IMPACTION.
Position of Limb.	
Thigh and leg flexed, adducted and rotated inwards.	Thigh and leg straight and rotated outwards.
Mobility of Limb.	
Mobility of limb is diminished.	Mobility of limb is increased.
Arc of Rotation.	
The trochanter rotates in its normal arc.	The arc of rotation of the trochanter is diminished.

* Ibid., page 423.

†Deutsche Militær ærzt. Zeitsch. 1873. No. 3.

FRACTURE OF THE RIM OF THE ACETABULUM.	FRACTURE OF THE NECK OF THE FEMUR WITHOUT IMPACTION.
Crepitus.	
Crepitation is not rough, and felt as the head passes over the broken edge of the acetabulum.	Crepitation is rough, and felt when the limb has been drawn down to its normal length.
Head of Femur.	
The head of the femur is felt to be displaced.	The head of the femur is normal in its position.
Retention.	
The deformity reappears if by any movement of the limb the head of the femur is made to leave the socket.	The deformity reappears as soon as extension ceases.
History.	
Is most frequent in middle life and is the result of great violence.	If intra-capsular in variety, it occurs in the aged, and is the result of slight violence.

Crepitus and a tendency to reluxation are the symptoms on which we place the most reliance, to differentiate this fracture from simple dislocation. The akystopeurastic of Middeldorpf may be of great service to determine the existence of fracture of the rim. After reduction has been accomplished, a long, stout needle is passed through the tissue to the supposed seat of fracture. By lateral movements of its point, the defect in the margin, as well as the roughness of its surface, is ascertained. An effort should now be made to fix the detached fragment with the point of the needle, and, by rubbing it over the broken margin, a rough crepitus is elicited.

PROGNOSIS.

The prognosis must have reference to the preservation of life and the restoration of the utility of the limb. All of the old authors regarded fracture of the pelvic bones a grave lesion, almost necessarily leading to a fatal termination. I believe with, Dr. E. Andrews,* that all uncomplicated fractures of these bones tend to recovery, and that death is attributable in most instances to a lesion of some important pelvic or abdominal viscera. In twenty-three cases where the result is noted in this regard, thirteen recovered and ten died. The prognosis is less favorable if the floor of the acetabulum is also implicated in the fracture. Of four cases of this sort, only one recovered. In nine cases out of the thirteen that

*Transactions of the Illinois State Medical Society, 1873.

recovered, the limb remained in place after reduction, and the recovery was complete. In four cases redislocation took place, the limb assuming the same malposition as after simple, unreduced dislocation of the femur.

TREATMENT.

The indications to be fulfilled in the treatment of this class of injuries are: 1st. To reduce the dislocation; 2d. To retain the head of the femur in the socket until union has taken place between the fragments.

The dislocation may be reduced by manipulation or by extension; in both instances, flexion constitutes an important step in the operation. Bigelow says:* "These displacements, especially the displacement backwards, demand the usual attempts at reduction by flexion. Although the bone inclines to slip from the socket, it can be retained there, in cases of a sort heretofore considered difficult of treatment, by angular extension, with an angular splint attached to the ceiling, or some other point above the patient; or if any maneuvre has reduced the bone, the limb should be retained, if possible, in the attitude which completed the maneuvre."

In seventeen of the case reported, the manner of reduction is specified as follows: By extension, eleven—in most of these cases extension and flexion were combined; by manipulation, two; by manipulation and extension, one; by manipulation over Sutton's fulcrum, one; by extension with pulley, two. In all but one of the cases the displacement was corrected without difficulty. In Pooley's case it was supposed that the detached fragment prevented reduction by being placed between the head of the femur and the acetabulum. In my own case, the use of the pulley was required from the length of time that had elapsed since the injury had been received. Had I been aware of the nature of the injury, no attempt would have been made to reduce the dislocation, as a restoration of the acetabulum could not be hoped for after such a long lapse of time since the injury was sustained. Permanent extension was applied more for the purpose of determining a favorable locality for the formation of a new joint, than with a view of retaining the head of the bone in its socket.

As in most instances a diagnosis cannot be made before reduction has been accomplished, surgeons will resort to their favorite methods of reduction. Should the nature of the lesion be determined beforehand, traction in the direction of the broken edge of the rim, and rotation of the limb inwards, will readily restore the normal relation of the parts.

* Dislocation hip joint.

As we possess no direct measures of keeping the fractured surfaces in apposition, all our efforts must be directed towards preventing reluxation, by appropriate position and fixation of the limb and pelvis.

The depth and extent of the fractured margin, as well as the location of the fracture, will determine the difficulty in retaining the head of the femur in its normal position. If sufficient depth of the upper portion of the rim is left to serve as a support to the head of the bone, all that is necessary is to dress the thigh in the abducted position, so as to press the head of the femur against the floor of the acetabulum. As the contusions of the soft parts about the hips and pelvis are severe, a plaster-of-Paris splint cannot be applied as a primary dressing. The healthy limb and pelvis should always be included in the retentive dressing.

Bonnet's wire breeches, Dzondi-Hagedorn's apparatus, or Hamilton's splint, as advised by him in the treatment of fractures of the femur in children, will be found sufficient to maintain retention.

After the swelling in the soft parts has subsided, nothing more perfect could be devised than a plaster-of-Paris dressing, including both limbs and the pelvis.

When nearly the entire depth of the upper or posterior portion of the rim has been detached, muscular contraction must be counteracted by permanent extension with the weight and pulley, and immobility of the joint secured by appropriate splints. In cases of this sort, angular extension with an angular splint, as advised by Bigelow, will answer an admirable purpose. The unbroken part of the rim should be made the support for the head of the femur whenever practicable, as when the posterior part of the rim is fractured, the thigh should be dressed in the position of hyper-extension, a broad, firm, pelvic band, with a compress above the trochanter, will aid in keeping the bone in place, in approximating the fractured surfaces, and in preventing muscular spasms.

The treatment should be continued for a sufficient length of time to secure a firm union of the detached fragment with the broken rim, which, as in other fractures, generally requires from four to six weeks. The patient must be directed to exercise great care in the use of the limb for a considerable length of time after all dressings have been removed, so as to obviate any undue pressure against the recently repaired rim of the acetabulum.